Task Force Ranger:

A Case Study Examining the Application of Advanced Technologies in Modern Urban Warfare

Frank H. Akers, Jr.
Vice President
Advanced Technologies
Lockheed Martin Energy Systems, Inc.
Oak Ridge, TN 37830

George B. Singleton
National Security Program Office
Lockheed Martin Energy Systems, Inc.
Oak Ridge, TN 37830
(865) 241-3854
singletongb@y12.doe.gov

February 2000

prepared by
NATIONAL SECURITY PROGRAM OFFICE
OAK RIDGE Y-12 PLANT
OAK RIDGE, TENNESSEE 37831-8260
managed by
LOCKHEED MARTIN ENERGY SYSTEMS, INC.
for the
DEPARTMENT OF ENERGY
UNDER CONTRACT DE-AC05-84OR21400

CONTENTS

EXECUTIVE SUMMARY

The purpose of this case study is to review the events surrounding the firefight that took place on October 3, 1993, in Mogadishu, Somalia, from a technology perspective. The focus is on how current technology could influence a similar incident and how technology could be used in a similar operation to reduce the number of causalities and to mitigate collateral damage in future combat situations.

Task Force Ranger's operation in Somalia provides a superb case study for examining the impact of technology on modern military operations. The events surrounding Task Force Ranger operations highlight examples in which certain developing technologies clearly could have made significant contributions, potentially saving lives and altering the outcome of the operation.

The men of Task Force Ranger fought bravely and with honor. They displayed immense valor and devotion to duty. There is nothing in this case study that is intended to criticize or second guess the decisions or actions of the commanders and soldiers charged with accomplishing this very challenging and difficult mission. Our nation owes each of them a tremendous debt of gratitude.

This report discusses the application of emerging technology in the challenging environment that existed in Mogadishu. It also addresses the difficulty of achieving the right technology overmatch in such challenging situations. The report concludes with discussions and recommendations in the following technology areas:

- Information
- Perception Analysis
- Command, Control, and Communications
- Situational Awareness
- Versatile Weapons with Enhanced Lethality
- Non-/Less-than-Lethal Weapons
- Visual Enhancements/Fused Sensors
- Psychological Operations
- Force Protection
- Compact, Portable Electric Power Sources
- Medical Care

1. INTRODUCTION

The purpose of this paper is to review the events surrounding the firefight that took place on October 3, 1993, in Mogadishu, Somalia, from a technology perspective. The focus of this paper is on how current and developing technology could impact a similar incident in the future and how technology could be used to limit causalities and to reduce the potential for collateral damage.

Task Force Ranger's operations in Somalia provide a superb case study for analysis of the impact of technology on modern military operations. Given the multipolar nature of the geopolitical environment and the increasingly diverse responsibilities placed on the U.S. military, similar circumstances will likely occur at some point in the future. We can expect our adversaries to use innovative and unexpected methods to engage forces of the United States (U.S.). These asymmetric approaches will include the most advanced, commercially available technology applied in an innovative fashion mixed with the crudest applications of extremely simple and unsophisticated weapons, tactics, techniques, and procedures. This unprecedented asymmetric technology mix will present tremendous challenges to a technologically sophisticated U.S. force operating unilaterally or as a component of a joint multinational force.

Additionally, in the coming years, our forces will face missions and adversaries unknown today. The increasing proliferation of sophisticated weapons and equipment in the hands of terrorists and rogue nations will place a tremendous burden on our nation's ability to field the most advanced and capable fighting force in the world. It will be extremely difficult and expensive to keep our fighting force at the cutting edge of technology and well ahead of our adversaries.

The events surrounding the Task Force Ranger operations highlight examples in which certain developing technologies clearly could have made significant contributions, potentially saving lives and altering the outcome of the operation from several perspectives. On the other hand, careful analysis of the events reveals many instances in which more and better technology would have made little difference. The Somalis' extreme lack of technological sophistication presented a very interesting challenge to the very sophisticated U.S. force.

This paper begins with a general discussion of the events leading up to and surrounding Task Force Ranger's October 3, 1993, assault to establish a common understanding of the environment and a clear picture of the challenges faced by the commanders and other participants in the operation. Such a discussion is necessary to understand the potential impact of applying developing technology. Next, the paper turns to a general analysis of technology and how it applied to this type of operational environment. Then, the paper provides specific observations, discussions, and recommendations

for applying developing technologies that could prevent a similar incident from occurring in the future and potentially reducing causalities and collateral damage should a similar operation occur.

While the tactics, techniques, and procedures (TTP) used by Task Force Ranger are quite interesting to discuss and analyze, every effort has been made to avoid such an analysis, which is outside the scope of this paper and the topic of other reviews. Additionally, such a discussion would result in this report being classified to protect those tactics, techniques, and procedures. This would significantly limit the utility of this report. However, some mention of generalized TTP is necessary and cannot be avoided when describing potential contributions current technology could make when applied in similar situations. The authors of this study have no intent to criticize the decisions or actions of the commanders and those charged with accomplishing this challenging mission in difficult circumstances.

A great deal has been written about the conflict in Somalia. Most of the published material focuses on the political aspects of these events at the national level. Very little open-source material addresses the specific operational activity of Task Force Ranger. There has been nothing published in an open-source, unclassified format that specifically addresses application of technology to Task Force Ranger's operations. After the events of October 3, 1993, in Mogadishu, the Department of Defense conducted after-action reviews and fully documented the events. Those reports remain classified. In preparing this report, we drew information from unclassified, open-source publications that are readily available to the public through printed media or are posted on various Web sites.

2. OPERATIONAL CONTEXT

With the end of the Cold War, the United Nations and the U.S. became increasingly involved in humanitarian operations around the world. Between 1945 and 1987, the United Nations approved only 13 peacekeeping operations. However, the multipolar world that developed with the breakup of the Soviet Union and the consequent thawing of the Cold War created numerous regional conflicts. These conflicts fostered the need for greater United Nations involvement in humanitarian operations. The United Nations approved 14 new peacekeeping operations between 1987 and 1992. This dramatic increase in operational activity by the United Nations did not come without a cost. During this period, over 800 United Nations peacekeepers from 43 countries were killed.[1]

By 1993, Somalia was in absolute anarchy. Since 1988, a civil war between the 14 clans and factions making up Somali society had completely

devastated the country. The civil war, aggravated by persistent drought conditions, created a famine of Biblical proportions. More than one-half million Somalis had starved to death, and at least a million more were threatened with starvation by the end of 1992.[2] The news media brought this extreme level of devastation and human suffering to the attention of the world community. The public's call for action eventually motivated the United Nations to launch the humanitarian assistance mission in Somalia.

In April 1992, the United Nations Security Council approved Resolution 751 establishing the United Nations Operations in Somalia (UNOSOM). UNOSOM's mission was to provide humanitarian aid and help end hostilities. The effort to relieve the human suffering in Somalia was handicapped from the beginning. UNOSOM faced two fundamental problems: (1) the logistics of moving enough food, water, and medical supplies around a large, mostly desert country with extremely poor infrastructure and (2) providing the security necessary to ensure the relief material did not fall into the hands of bandits or become confiscated by one of the clans or warring factions.[3]

There were three stages to U.S. involvement in these humanitarian assistance operations in Somalia. The first, Operation Provide Relief, was organized by U.S. Central Command (CENTCOM) and ran from August 15, 1992, through December 9, 1992. CENTCOM's mission during Operation Provide Relief was to "provide military assistance in support of emergency humanitarian relief to Kenya and Somalia." CENTCOM's activities in support of Operation Provide Relief included deploying a Humanitarian Assistance Survey Team to assess relief requirements, activating a Joint Task Force to coordinate an emergency airlift of food and supplies to the region, and deploying Air Force cargo aircraft to provide daily sorties to airlift supplies into various secure locations in Somalia. During the period of Operation Provide Relief, the Joint Task Force averaged 20 airlift sorties per day and delivered approximately 150 metric tons of humanitarian relief supplies into Somalia by air alone.[4]

Despite this steady flow of relief supplies, the security situation in Somalia continued to deteriorate, largely due to the increasing belligerence of the various clans and warring factions. In response to the deteriorating security situation in Somalia, the United Nations passed Resolution 794. This resolution called upon the U.S.to lead a multinational coalition called the United Task Force (UNITAF). UNITAF's role was to bridge the gap until the security situation in Somalia stabilized enough to hand responsibility over to a permanent United Nations peacekeeping force. United Nations Resolution 794 implied two important roles: provide humanitarian assistance and restore order in southern Somalia.[5] In response, President Bush announced the initiation of Operation Restore Hope on December 4, 1992. The U.S. military's role as a member of UNITAF was dramatically different from that of the previous relief effort.

UNITAF was active from December 9, 1992, to May 4, 1993, and involved more than 38,000 soldiers from 21 nations, including 28,000 U.S. military personnel. UNITAF was quite successful in stabilizing the security situation in Somalia. The improved security situation allowed delivery of more relief supplies throughout the country, reducing the threat of famine and starvation in many areas.[6]

After repeated delay by the United Nations Secretary-General Boutros-Ghali, the Security Council passed Resolution 814 on March 26, 1993. This resolution established United Nations Operations Somalia II (UNOSOM II) as the peacekeeping force to follow UNITAF. UNOSOM II was given the specific mission to disarm the Somali clans, to rehabilitate the political institutions and economy of Somalia, and to build a secure environment throughout the country. UNOSOM II was organized as a full United Nations peacekeeping structure, headed by retired U.S. Navy Admiral Jonathan Howe. Turkish Lieutenant General Cevik Bir was named Force Commander of the multinational contingent. The primary role of the U.S. in UNOSOM II was to provide logistical support and a quick reaction force. At the peak, there were 4,500 U.S. personnel supporting UNOSOM II.[7]

The continued presence of the multinational force and its mandate to build a secure stable environment in Somalia threatened the power base of the clan warlord, Mohammed Aideed. Acting on Aideed's orders, his clan became increasingly belligerent toward UNOSOM II. This increasing belligerence included daily firing of mortar rounds into the United Nations compound and terrorizing and executing Somali employees of the United Nations mission.

On June 5, 1993, Aideed's supporters ambushed and killed 24 Pakistani soldiers. This dramatic event led to the United Nations Security Council passing United Nations Resolution 837. This resolution called for the apprehension of those responsible for the ambush of the Pakistani soldiers.[8] Admiral Howe pressed the administration in Washington to deploy a special operations task force specifically trained and equipped for the task and to respond if any United Nations workers were taken hostage by Aideed's clan.

In response to Admiral Howe's pressure and continued belligerent actions by Aideed's supporters, the administration finally approved deploying Task Force Ranger to Somalia in August 1993. This approval came only after four U.S. Marines were killed and seven others were wounded in two separate incidents involving remote-controlled land mines.

Task Force Ranger's mission was to find and capture Mohammed Aideed. Task Force Ranger's chain of command was separate from that of the other U.S. forces in UNOSOM II. Major General William F. Garrison was the Task Force Ranger Commander. He reported directly to the Commander-in-Chief U.S. Central Command without going through United Nations channels. Major General Garrison maintained a close working relationship

with the commander of the U.S. forces supporting UNOSOM II, Major General Thomas Montgomery.[9]

The arrival of Task Force Ranger in Mogadishu did not go unnoticed by the international media and the Somalis, including Aideed. While a great deal of operational security did surround Task Force Ranger, the knowledge that they were in Mogadishu specifically to apprehend Aideed caused Aideed and his leaders to go into deep hiding. This made it extremely difficult to gather accurate intelligence on Aideed's activities and location. In addition to apprehending Aideed, Task Force Ranger targeted Aideed's command and staff structure.

Task Force Ranger was a battalion-size, self-contained, joint force consisting of elements from each of the components of the U.S. Special Operations Command (USSOCOM) with selective augmentation from conventional forces. The force had at its disposal the most sophisticated equipment available. Task Force Ranger had access to virtually every product of our national level intelligence collection architecture and received Human Intelligence (HUMINT) collection support not normally provided to a force of its size. In the interview he granted *Frontline*, Major General Montgomery indicated that there was an augmentation for human intelligence collection and that Task Force Ranger "had their own capability and they had some very sophisticated technology."[10]

In his book, *Black Hawk Down – A Story of Modern War*, Mark Bowden provides a very interesting description of Task Force Ranger's normal concept of operations. Task Force Ranger's methods of operations were relatively simple and straightforward. They were prepared to launch an assault in an extremely short time frame, usually a matter of minutes. This level of readiness required an extreme level of organization, training, and rehearsal to plan and launch an assault in such a compressed time line. The force was able to achieve this extraordinary level of response by employing tactical templates that had been rehearsed countless times in fully integrated training scenarios. These tactical templates were easily modified to adapt to specific tactical situations that developed. In many respects, the commander acted much like a football quarterback calling a play in the huddle and then calling an audible at the line after seeing how the defensive team lined up. In an interview he conducted for *Frontline*, Major General Montgomery presented a very descriptive portrayal of Task Force Ranger's rapid planning and execution ability. He said,

> … the nature of their operations is that they get short notice and they are very adapted to making a quick plan and launching a quick strike. What would take us several days to plan, would take them maybe 20 minutes to plan.[11]

Major General Garrison required verified actionable intelligence before launching an assault on a target. Normally, the force received HUMINT reports that a meeting involving important individuals would be or was taking place at a specific location, or perhaps, that a targeted individual would be moving from one location to another. Major General Garrison would then direct an airborne intelligence collection platform to verify the report. If they were unable to verify the report, the force would not conduct the assault. Such verification was extremely difficult in the environment that existed in Mogadishu.

Task Force Ranger depended on rapid response and minimal time on target once they conducted the assault. They normally were on the target for just a matter of minutes before they began exfiltration. To maintain some measure of tactical surprise, they varied their infiltration and exfiltration modes. Sometimes, they went in via helicopters and used vehicles to return to the airport. At other times, they did the opposite. There were times when they used helicopters exclusively and other occasions when they were not used at all. Task Force Ranger frequently launched the force in helicopter assault profile flights around the city to desensitize the population to the presence of helicopter formations flying overhead. These flights were called signature flights. When a signature flight launched, the Somalis were not supposed to know if it was an actual assault or another signature flight. In general, the signature flights did seem to reduce the sensitivity to the helicopters flying over the city and improved by a small measure the tactical surprise needed to successfully conduct assaults.

A typical assault involved Rangers rapidly establishing blocking positions at four corners around the targeted building. These blocking positions were intended to provide exterior security for the surgical force that would quickly enter and search the target building. Normally, in just a few minutes, the target was secure and all Somalis inside the security perimeter were disarmed cuffed, and searched. If individuals on the target list were present, they were then moved to the designated pickup zone for return to base. Once this occurred, the force departed as rapidly as they arrived. Although the assault force relied on speed, surprise, and violence of action to accomplish their mission, very little firing of weapons actually occurred during most missions.

The assault, which occurred on October 3, 1993, was the seventh assault Task Force Ranger had conducted since their arrival in Mogadishu. Each of these assaults was different and achieved varying levels of success. However, by October 3rd, they had become very confident in their ability to operate in the environment and were beginning to have an impact on Aideed's command structure. By this time, they had apprehended several of Aideed's key subordinates. However, on the other hand, Aideed and his supporters were gaining a better understanding of Task Force Ranger's operational methods.

3. TECHNOLOGY IN THIS ENVIRONMENT

What Technology Applies in this Environment?

This is truly a difficult question to answer. The complex operational environment faced by the commanders, staff, and operators of Task Force Ranger proved extremely challenging. The environment was very complex and should be viewed from different perspectives.

The impact of the physical environment on Task Force Ranger operations is readily apparent. For the most part, Task Force Ranger was as well prepared to operate in the urban environment of Mogadishu as any force in the world. Elements of the Task Force regularly conducted realistic training in urban environments and were extremely well equipped and skilled in the close house-to-house fighting involved in urban combat. Such realistic training is critical to maintain the necessary level of proficiency for fighting in an urban environment. Unfortunately, most conventional military units do not have the ability to train in urban settings with the intensity and frequency as the elements of Task Force Ranger.

The cultural environment existing at the time in Mogadishu was extremely unique and significant to the operation's outcome. The U.S. military rarely gains a full understanding of the impact this aspect may have on its operations, particularly in peacekeeping or peacemaking situations. The members of Task Force Ranger may not have fully appreciated the complex nature of the Somali society. In the introduction to his series of articles published in the *Philadelphia Inquirer* titled "Black Hawk Down," Mark Bowden described the nature of Somali society very well:

> Mogadishu was a bewildering complex of interlocking family and kin. It was protected not by formal army or battlements, but by hordes of gunmen. Its warriors were kids with automatic rifles and grenade launchers who hung around the villages looking for trouble.[12]

This interlocking web of family and kin into a closely knit community presented tremendous challenges for gathering accurate HUMINT. Those who were not members of the clan were readily identifiable and were immediately suspect and given little access to the community. Also, clan members were unwilling to provide information about other clan members to the United Nations forces. This problem cannot be solved using a technology approach alone.

The complex Somali society would have provided very good opportunities to employ psychological operations to condition the environment. For the most part, Task Force Ranger did not use existing psychological operations capabilities within the U.S. military. Potentially,

psychological operations could have been used as a force multiplier and assisted in achieving a positive outcome with fewer casualties. On the other hand, Aideed and his lieutenants were very adept at influencing the perceptions of Somali people and their willingness to fight against United Nations forces. They were also very skilled at using the media to achieve their ends and influence world opinion.

From the very beginning, military leaders are taught to consider the impact of terrain, weather, and other aspects of the physical environment on their operations. The same is not true for the political environment. When considering peacekeeping and peacemaking operations, the impact of political influences can be significant. The size and capability of Task Force Ranger was limited for what were largely political reasons. These limits restricted options available for the commander and reduced the resources available to conduct the operations and protect the deployed force.

Another aspect of the political environment was the unacceptability of U.S. casualties. The Persian Gulf War created a perception that military operations, relying on high-technology equipment, can be conducted cleanly and without casualties or collateral damage. A report published by the Center for Strategic and International Studies found "at the very heart of the military-technical revolution lies the belief that American military power can henceforth achieve success without significant loss of American life."[13] Aideed knew fully well that the center of gravity for the U.S. involvement in Somalia and ultimately that of the United Nations was the unacceptability of U.S. casualties. He knew that by inflicting U.S. casualties the American political leadership would be forced to withdraw U.S. forces.

Another significant aspect of the operational environment is the complete asymmetric level of the technology employed by the opposing forces. At the time, Task Force Ranger was the most technologically advanced special operations task force in the world. On the other hand, Aideed's clan was equally unsophisticated. They used the simplest of weapons and made minimal use of modern communications equipment. This extreme dichotomy presented problems for Task Force Ranger. For example, since Aideed's supporters rarely used telephones or radios and did not have any radar controlled air defense systems, most of the U.S. communications and signal intelligence gathering systems were of limited use. They were thus forced to rely almost exclusively on human intelligence. Such intelligence was extremely difficult and dangerous to collect in Mogadishu.

The general preference of conventional U.S. military forces is to stand off at great distance and engage the enemy with clean, technologically sophisticated, precision-guided munitions. This approach was of very little value while fighting in the complex maze of streets, alleys, and shanties that made up most of Mogadishu. In the dirty, dangerous house-to-house fighting which occurs in an urban setting, confident leadership, solid training, teamwork, and excellent marksmanship are often more important than

technology. This same lesson was learned by Russian forces in their 1994-95 fighting against Chechen forces in Grozny.[14]

However, this is not to say that improving and applying technology in this environment should not be considered. Advanced technology can make a significant difference in reducing casualties; providing enhanced situational awareness; facilitating the collection, analysis and dissemination of intelligence data; and protecting the force.

Was the Available Technology Used Properly?

Task Force Ranger was the most technologically advanced military force in the World in October 1993. Theoretically speaking, Task Force Ranger had access to much of the most advanced technology available to U.S. forces. They used a great deal of interesting technologically advanced equipment that was not available to other conventional forces.

In an interview for *Frontline*, Keni Thomas, a former U.S. Army Ranger and member of Task Force Ranger, stated, "When we looked at the mission, the equipment, the terrain, the time to accomplish the mission, and the troops available we were certain we had everything needed to be successful."[15]

Not all the available technology was used in this operation. There are a number of practical reasons the commanders chose not to employ certain technologies and why some potentially useful technology was effectively not available.

One reason for not using available technology was the imposed limits on the physical size of the force that could be deployed into the area of operations. These limits were placed on the force by the highest levels of their chain of command for both political and practical reasons. Inclusion of many technologies would have required a corresponding increase in the size of the deployed force. The cap on the force size caused the task force commander to exclude certain capabilities or potentially useful technology in order to deploy as much fighting strength as possible and remain with the cap on total personnel deployed. A good example of this is the use of AC-130 gunships. AC-130 gunships had been used in Somalia very effectively in the previous months. However, none were deployed in the area of operations when Task Force Ranger deployed to Somalia and thus were not available to support their operations. Adding AC-130 aircraft to Task Force Ranger would have increased the size of the task force a great deal. This was unacceptable in the environment that existed at the time.

Another obvious reason participants chose not to use some available technology was that the commanders and operators felt that they did not need the particular technology at that specific moment in the operation. The best example of this is the use of night vision equipment. Most of the raids

Task Force Ranger conducted were at night. When operating at night, the operators used the most advanced night vision equipment available. However, the raid conducted on October 3, 1993, was a daylight raid. Most chose not to bring along their night vision equipment because they thought they would not need the equipment during the expected, short daylight raid. As events developed, night vision equipment would have proven very helpful.

An additional reason that specialized technology sometimes is not used is due to security restrictions. Often the most advanced technology is protected by levels of security that effectively prevent its use. Commanders are reluctant to use equipment that has not proven its value and reliability in numerous training events. This phenomenon is especially true of high-technology equipment. Often, selected personnel in the acquisition and security community are aware of the equipment through special technical operations (STO) channels. However, commanders and the operators who would employ the equipment are not aware of the capability because they have never been read-on to the program for security reasons. Reading them into a specific compartmented program at the last moment does not work because they would not have the opportunity to train with the equipment before employing it operationally.

For special operations forces such as Task Force Ranger, the issue of security limits their access to technology for another reason. In some cases, the cloak of secrecy surrounding special operations forces prevents those developing potentially useful technology from being aware of the special operations force's requirements. The cloak of secrecy also limits the ability of most developers of technology to understand or comprehend the innovative applications those special operations forces may have for the new technology.

Task Force Ranger did not employ any light armored vehicles in their ground operations. Other than the light armor under the control of the Malaysian and Pakistani contingents of UNOSOM II, there were no armored vehicles available in the country. For their ground operations, Task Force Ranger used regular army trucks piled with sandbags to provide some protection from hostile fire.

As early as June 1993, Major General Montgomery had officially requested armored augmentation to improve force protection for U.S. elements of UNOSOM II. His initial request for M-1 Tanks and a subsequent request for a much smaller mechanized element containing only M-2 Bradley Fighting Vehicles were disapproved for what were largely political reasons. The leadership in Washington did not want to increase the size of the force at a time when the force was supposed to be getting smaller. The leadership back in the U.S. believed that sending armored forces to Somalia would make it appear that what was supposed to be a peacekeeping operation was turning into a combat operation.

On a practical side, the armor currently available to U.S. forces is not well-suited for operations in urban environments such as Mogadishu. Task

Force Ranger may not have used armor to support their operations even if it had been available in order to maintain operational security and enhance tactical surprise.

Was There a Technology Failure?

In the case of Task Force Ranger's operations, the technology employed did not fail. In most cases, it performed as well as or better than expected.

The factor most responsible for the dramatic turn of events in Mogadishu on October 3, 1993, was the downing of the two Black Hawk helicopters by rocket-propelled grenades (RPGs). The Black Hawk was designed to be a tough aircraft and thus not easily shot down. However, the aircraft was not designed or intended to take multiple RPG-7 hits. The fact that one aircraft was hit and managed to return to the airfield is a testament to its toughness. Task Force Ranger was prepared to deal with one aircraft down but did not have the combat search and rescue (CSAR) resources, personnel, or equipment, to effectively manage an incident involving two or more aircraft down in separate locations. This was partially a function of the limit on the size of the deployed force and a result of the fact that all considered the possibility of two or more aircraft going down in separate locations remote. Additionally, presently there are no technological counter measures to protect low-flying helicopters from RPGs.

This positive characterization of the performance of technology is not to imply that efforts should not be made to improve and advance the technology available to U.S. military forces. Technology continues to move forward at a fast pace. The significant advancements in technology experienced in the last several years have created a situation where there is a widespread proliferation of advanced weaponry and military equipment, much of it readily available on the commercial market. In the future, U.S. forces will face terrorist groups and adversarial military forces equipped with extremely advanced technology purchased openly on the commercial market. It is imperative that the U.S. continue to invest in making state-of-the-art technology available to our military forces.

Achieving the Right Technology Overmatch

Achieving the right technology overmatch in an environment such as existed in Mogadishu is extremely difficult. Clearly, the unsophisticated technology in the hands of Aideed's clan was no match for the very advanced equipment employed by Task Force Ranger. However, employing advanced technology for the sake of employing advanced technology is not the answer. The technology employment must be focused appropriately. The key is to match the technology to the adversary's weaknesses or vulnerabilities.

Aideed and his supporters understood this. Aideed knew that Task Force Ranger's greatest vulnerability was the unwillingness of the political leadership and the public in the U.S. to sustain casualties in military operations. Thus, by employing large numbers of unsophisticated RPG-7s and assault rifles at an essential vulnerability, he effectively achieved his objective.

The ability to focus technology directly at an adversary's vulnerabilities is critical to success. However, this focus will remain tremendously difficult to achieve for U.S. forces given the broad scope of missions and environments they are likely to face in the future. This is particularly true in what is surely to be a resource-constrained environment for the foreseeable future. Decision makers will have to carefully weigh many factors to achieve the right technology mix for general-purpose U.S. forces. On the other hand, it is critical that certain elements within the Department of Defense receive adequate resources to achieve and maintain a sustained broad range of technology enhancements. The special operations forces drawn upon to form Task Force Ranger must receive the benefits of these technology advancements. Effective technology transfer mechanisms should be established to leverage the most promising of these technology advances to the force at large.

Another essential factor in ensuring that appropriate technology for the environment is available for employment when needed is to involve actual users in each step of the developmental process. Informed and experienced users must be included in the requirements development and validation process, resource allocation phase, and each step of the development, testing, evaluation, and fielding. If informed and experienced users are not involved, the potential for wasted resources grows and the appropriate technologically advanced equipment will not be available when needed. User involvement must be a cornerstone of Department of Defense acquisition reform efforts.

To achieve the appropriate technology overmatch requires a flexible and responsive technology development and acquisition process. The process must be able to adapt rapidly to changes in the environment and allow for taking advantage of unforeseen technology advancements. In the last several years, the Department of Defense has made a concerted effort to reform its acquisition procedures and reduce the time necessary to bring new technology to the force. The drive to reform has significantly improved the acquisition system's responsiveness and ability to capitalize on technology developments. However, more reform remains necessary to create a system which is truly adaptable to changing needs of the war fighters. The system that should provide technology to the war fighters must do a better job. Nevertheless, it is difficult to implement real reform because of the strangling effects of bureaucracies and the intellectual lethargy of many of those involved in the process.

4. SPECIFIC TECHNOLOGY RECOMMENDATIONS

Information

A. Observation – The intelligence collection, analysis, and dissemination system supporting Task Force Ranger did not provide all the specific information required by the commanders.

B. Discussion – One way to improve the intelligence system's response, which relies on technology, is to use intelligent agents/wizards to help the commander sort through what explicit information requirements are necessary, exactly when the information is needed, and what form (visual or textual) the information is needed in. Moreover, intelligent agents could help people form relationships among obvious and seemingly disparate things. These relationships are what people need to *understand* their environment, not just to *know* things.

C. Recommendation – Commanders at every level must learn to understand how they are thinking through operational problems they face and how to explicitly state their information requirements. Commanders should receive tools that use intelligent agents/wizards to help sort through what explicit information requirements are necessary.

Perception Analysis (Mirror Imaging)

A. Observation – Often commanders and staff planing a military operation fall into the trap of mirror imaging.

B. Discussion – Mirror-imaging occurs when, in assessing your opponent or competitor, you overlay your own value set, religion, culture, thought processes, and so forth on top of the person or group you are trying to assess and anticipate their action or response. This phenomenon may have been responsible for some of the problems in Mogadishu and many other military operations the U.S. has conducted.

This is a difficult problem to solve. Commanders can rely on expert help, but typically, they do not do well either. We have to be aware of our proclivity to fall into the intellectual trap of mirror-imaging.

Moreover, commanders and their staffs could use smart agents and analytic programs to help, but the software application specific to the situation would have to be written by their opponents. Even then, they would have to be very careful not to fall in to the mirror-imaging trap. This type of technology can fit into virtual reality schemes in which a key individual can enter a virtual representation of the operational environment. In this virtual environment, avatars (icons or representations) assume the personality, culture, religion, and education of the opponent and act against us — act,

react, counteract. The avatar would learn and get smarter with time and experience, owing to neural networking and genetic code. This representation of our opponent would be more difficult to beat with the passage of time in these adaptive wargaming sessions.

C. Recommendation – Explore the application of virtual reality schemes employing neural networking and genetic code to provide avatars that act as our opponent.

Command, Control, and Communications

A. Observation – The command, control, and communications systems employed by Task Force Ranger did not facilitate the flow of adequate information and contributed to the "fog of war" or confusion which developed during the engagement. The events in Somalia show how poor communications accentuate the confusion that exists in combat during times of danger, fatigue, fear, and death.

B. Discussion – The communications equipment and systems used by Task Force Ranger were fairly advanced for the time and were significantly more robust than those available to other conventional forces and their opponents. However, when measured by the standard of current and emerging technology, their communications were quite crude. Most of the systems were line-of-site radios that typically do not perform well in urban areas without wide use of repeater devices. Buildings and other structures create dead space and multipath transmission and reception problems.

In contested urban settings, like that of Mogadishu, it is difficult to emplace repeaters in secure and concealed locations that will provide adequate coverage and ensure reliable and redundant communications. One solution is to use satellite surrogates (UAV, high altitude balloon, and Single Purpose Inexpensive Satellite Systems, which go by many names including cheapSat and LightSats) as radio relay platforms. Applications of emerging technology must allow us to provide near real-time secure voice and imagery to those operating in urban environments.

The imaging system must be responsive to the needs of small units that need to "see around the corner" and in buildings. Imagery must be available to soldiers and leaders in heads-up displays and other reliable display formats that do not require significant effort to use or create a distraction to the operator engaged in the multiple task, high demand in urban combat.

C. Recommendation – The Department of Defense should invest in technology which enables a communications structure that provides secure, reliable, redundant and fully interoperable across all elements of a joint task force and easily integrates into a multinational architecture. This communications structure must support a new command schemes that allows

leaders to see some of what their soldiers see. The soldiers and their leaders need to be able to enter virtual reality situations to wargame, collaborate with experts, and access the type of information they need. Such architectures are possible through the use of advanced distributed computing and mobile networking technologies.

Situational Awareness

A. Observation – During the October 3, 1993, engagement, commanders, staff, and operators lost some situational awareness as events became increasingly confusing. Situational awareness includes an awareness of their location relative to other individuals and elements of the force, the status of various activities under way, and responsive receipt of amended orders and reports. There is a direct relationship between improved situational awareness and improved force protection.

B. Discussion – Just as in every military conflict since the dawn of time, a certain measure of confusion developed when Task Force Ranger clashed with the Somalis on October 3, 1993. Prussian General Carl Von Clausewitz, the famous military theorist, described this phenomenon as the "fog of war." A good example of this confusion is described in *Black Hawk Down*.[16] The author, Mark Bowden, describes the commander's attempts to provide directions necessary to direct the ground convoy's movement to the helicopter crash sites. Task Force Ranger was equipped with very sophisticated radios to provide secure communications links with every element of the force. Yet, some confusion developed about the location of the downed helicopters, the best route for the ground convoy to reach them, specific intentions for the ground convoy, and where other friendly forces were located relative to each other.

Advanced information management technology could significantly improve the information available to the commander, to each element of the task force, and to many individual members of such a task force. This improved flow of information would reduce the potential impact of the "fog of war." Secure broadband communications equipment, currently under development, using mobile networking algorithms will dramatically improve situational awareness for every element of a force equipped with such communications devices. When combined with emerging microtagging technology, the location and status of every individual or element within the force can be displayed or transmitted to any other individual or element with virtually no operator involvement. Automated processing and filtering of this information can provide accurate, tailored information for a multitude of purposes.

Research and development over the last several years has yielded the capability to provide the location and status for the large platform elements

of a joint force (e.g., ships, aircraft, and some large vehicles). Soon, advancing technology can provide extraordinary situational awareness to the individual level. This enhanced situational awareness within a task force will allow for rapid, accurate, and secure transmission information (such as threat warnings, orders, situation reports, and other friendly force locations) and provide navigation aids to every element of the force.

Emerging mobile ad hoc networking technology will allow each node within a network to easily pass large quantities of information to any other node. In such a network, the signal automatically routes its way through the network to the intended recipients. The network dynamically reconfigures itself as necessary to account for movement of the nodes and overcome line-of-site and radio frequency multipath problems common in urban environments.

When secure broadband communications techniques are combined with mobile networking and micro-transmitter technology, the potential applications are virtually endless. In addition to friendly force location and identification, these technologies could be applied to develop navigation aids for urban operations, reference point markers, smart communications repeaters, suites of unattended sensors, automatic reporting sensors for aircraft and vehicles, and any number of other applications.

C. Recommendation – Resource the development of situational awareness aids that integrate the emerging technology in the fields of micro-tags/transmitters, mobile ad hoc networking, and secure broadband communications.

Versatile Weapons with Enhanced Lethality

A. Observation – When fighting building to building in urban environments such as Mogadishu, soldiers require versatile, lethal, and accurate weapons.

B. Discussion – The fighting in Mogadishu pitted a superbly trained and disciplined force against what was virtually a heavily armed, mass mob coming from all directions. Unlike fighting in open terrain, where volume of fire can be the deciding factor, well-aimed accurate shots are critical in an urban environment.

In closed urban settings, large volumes of fire can prove counterproductive. Bullets will ricochet in unexpected directions, buildings and other flammable objects can catch fire, and noncombatants can be unintentionally hit. Currently used high-velocity ammunition will penetrate glass, wood walls, and some masonry construction. When fighting in a city, leaders must place significant emphasis on fire discipline and maintain situational awareness to avoid fratricide and unintentional collateral damage. Rounds penetrating a wall could hit noncombatants or friendly forces.

Recent developments in frangible ammunition can help reduce the potential for fratricide and collateral damage. Frangible projectiles made from compressed tungsten powder provide superb ballistic characteristics, yet can be tailored to disintegrate when striking a hard object and remain quite lethal when striking a person. This can prove valuable when fighting room to room in a building where interior walls are usually quite thin. Such versatile ammunition can be produced in any caliber and tailored to perform in ways unavailable with existing lead, copper, or jacketed ammunition. Frangible ammunition made from compressed tungsten powder is also environmentally safe. Frangible projectiles are made from nontoxic materials, thus avoiding the cost and time associated with cleaning up contaminated ranges.

Resupply is difficult in street fighting. Well-aimed shots conserve ammunition, thus reducing ammunition resupply requirements. In circumstances where a force is vastly outnumbered and surrounded, as occurred in Mogadishu, accuracy and lethality are critical requirements. Each shot must hit and each shot must kill.

Aggressive training in urban settings, significant range time, and frequent live fire exercises are critical for keeping a force ready to fight effectively in a city. Training must emphasize marksmanship, fire discipline, target recognition, and situational awareness. The soldiers of Task Force Ranger trained hard, spent a great deal of time on the range, and conducted frequent live fire exercises. Yet, they still faced a difficult fight in the streets of Mogadishu.

One other factor that helped Task Force Ranger prevail over the Somalis was the quality of their weapons. Task Force Ranger was equipped with better weapons than their opponents. Increasingly, high-quality technically sophisticated weapons are readily available on the open market to anyone with the money to purchase them. We must leverage technology to ensure that U.S. forces are equipped with superior weapons than our opponents.

Currently, the U.S. Army is the executive agent for two joint weapons programs that are attempting to integrate emerging technologies into very lethal versatile weapons. These programs are the Objective Individual Combat Weapon (OICW) and the Objective Crew Served Weapon (OCSW). Both of these programs are intended to develop weapon systems incorporating state-of-the-art optoelectronic fire control, advanced materials, and enhanced lethality ammunition to provide soldiers with lightweight, highly lethal small arms. Significant technical hurdles remain, as well as the challenge of reducing the weight of these systems, while maintaining or improving their lethality. One route to enhanced lethality is through use of mixed powdered metal techniques to build an enhanced anti-personnel or material projectile. When combined with emerging miniature fusing technology, a very lethal projectile could be built in the 20 and 25mm calibers envisioned for of OICW and OCSW.

In another weapons development effort, USSOCOM is working closely with Saco Defense, Inc., and Computing Devices of Canada to field an innovative automatic grenade launcher, call the Advanced Lightweight Grenade Launcher (ALGL). ALGL integrates an advanced electro-optical fire control system with an innovative automatic grenade launcher design. When matched with programmable ammunition that is under development, the system will allow accurate day or night target engagement and will greatly enhance the probability of a target hit with the first burst. There are also excellent weapons under development by foreign countries and commercial ventures.

C. Recommendation – Need additional research into improved optics; laser range finders; integrated optoelectronic fire control; programmable ammunition; lightweight composite and advanced materials; and cheaper, safer, and cleaner training ammunition. The goal should be to field multirole/multipurpose weapons with target discrimination and integrated fire control. Where possible, the Department of Defense should encourage innovative ideas and teaming arrangements with industry.

Non-/Less-than-Lethal Weapons

A. Observation – During the operations in Mogadishu, just as in most peacekeeping and peacemaking operations, there were problems controlling the crowds that always seem to gather when a military force moves into their area.

B. Discussion – It appeared that part of Aideed's strategy was to assemble large crowds around United Nations Forces as they moved through the city. As Aideed's clan became increasingly belligerent, these crowds became more than a hindrance. They were a threat to the soldiers' safety and security. The United Nations troops were reluctant to use their weapons to keep the crowds at a distance. This reluctance was enforced by the existing rules of engagement for United Nations forces. The Somalis were aware of this reluctance and did not see the United Nations peacekeeping troops' weapons as a credible threat. Additionally, Aideed's fighters cared little if women and children were killed by United Nations troops. When such an incident occurred, they used the media to turn the event in their favor.

Military forces assigned humanitarian missions currently do not have effective tools to manage non-cooperative crowds of noncombatants without resorting to lethal force. When placed in these uncertain and dangerous situations, troops must always have a means of self-defense and must be allowed to ensure their personal safety. However, they are not given many effective options short of lethal force. Troops in these situations need a full range of options.

The Joint Non-Lethal Weapon Program (JNLW) is making progress toward filling this void. The JNLW 1998 annual progress report indicates "Non-lethal weapons are now developed to a point that they are a viable option for policy/decision makers and tactical commanders… "[17] While this may be the case, there is still much that can be done to improve the tools available and provide additional options to policy/decision makers and tactical commanders. Actual users with real experience in humanitarian and combat operations must be involved from start to finish to provide an honest appraisal of the utility of potential technology. This will save much time, effort, and money by preventing the acquisition system from chasing technology the war fighters will not or cannot use.

C. Recommendation – Continue to support research into new technology which may have applications supporting non-lethal objectives. Involve actual users with real experience in both humanitarian and combat operations in every step of the developmental process from requirement definition to actual capability fielding.

Visual Enhancements/Fused Sensors

A. Observation – Task Force Ranger had the most advanced visual augmentation systems available in October 1993. Although the equipment was the most advanced available at the time, it had limitations that restricted the effectiveness of the force. Technology continues to provide advancements that can improve the ability of U.S. forces to operate in all environmental conditions.

B. Discussion – The October 3, 1993, raid occurred in daylight, so most of Task Force Ranger's members did not carry their night vision equipment. Previous raids conducted during darkness proved the value of their night vision equipment. The equipment provided a decided advantage to Task Force Ranger during the hours of darkness.

Their night vision goggles and weapon sights provide a very limited field of view and greatly restrict peripheral vision. Current goggles tend to "whiteout" or "bloom" when there is sudden bright light from weapons firing or explosions. Existing equipment limits visual acuity and does not allow color recognition.

For a number of years, the U.S. military could claim that they "owned the night." However, with the continued widespread proliferation of image intensification night vision devices, this will no longer be the case in the near future. U.S. forces have come to rely on a number of related technologies, such as laser aiming devices, laser pointers, and infrared markers. These items greatly assist the control and movement of troops and their weapons fire at night. However, when the opponent has similar night vision equipment, it can also become a liability. To retain the edge over potential

opponents, we must continue to develop technology, which allows us to see better than our opponents and use their technology against them.

Thermal vision technology shows great promise and is being widely fielded in larger combat vehicles. Although there are significant technical hurdles, similar thermal vision technology must be made available for light and special operations forces. Employing thermal systems in light and special operations forces will require some changes in tactics, techniques, and procedures. It will also necessitate development of the associated equipment such as pointers, markers, and friendly force identification techniques.

The ultimate in visual augmentation will result from a fusion of the two technologies into a form that is useful for the light or special operations warrior. This fusion should combine the best of both technologies and allow our troops to see in all environments regardless of light level or presence of obscurants. This will also allow effective employment of obscurants for force protection and deception.

There are a number of supporting technologies which will eventually make this fusion possible. Department of Energy sponsored research is developing micro-cantilevers that show promise for integration into a number of devices, including visual augmentation systems. The continued rapid improvements in development of micro-computing devices will allow the development ASIC chips with the signal processing capability to manage the input from fused sensors. This advanced signal processing capability will require advances in display technology to provide an effective heads-up display. Effective sensor fusion will also require advances in batteries and power management.

C. Recommendation – Support continued research into the integration of sensor fusion and supporting technology to provide war fighters greater visual augmentation capability. The goal should be for our war fighters to be able to see in all conditions, regardless of illumination and obscuration level, as well as they can see in the daytime.

Psychological Operations

A. Observation – Psychological operations employing advanced technology could prove quite effective in operations such as that conducted by Task Force Ranger. Psychological operations can reduce the population's willingness to support a warlord such as Aideed and encourage them to cooperate with peacekeeping forces. Potentially, effective application of psychological operations could have made it possible to accomplish their mission without conducting the assaults such as the one on October 3, 1993. The widespread surrender by Iraqi troops during Operation Desert Storm is proof that psychological operations can have a dramatic effect on the opposition.

B. Discussion – There apparently was little use of psychological operations by UNOSOM II or Task Force Ranger other than the general intimidation effect of their presence and the frequent signature flights over the city. The tools available for conducting psychological operations are relatively primitive and represent very little innovative thought. These limited tools severely restrict the effectiveness of psychological operations as a whole; thus, commanders are often distrustful and reluctant to use psychological operations at the tactical level. The tools typically employed in psychological operations are simple printed media, pamphlets or newspapers, distributed to the target populace for the use of local radio broadcasts. The psychological operations community has begun to use television broadcasts as a tool.

This should not be taken as overly critical of the personnel within the U.S. Army who are charged with conducting psychological operations. They have not received the necessary priority or adequate resources to address the application of new technology to their field. Additionally, the requirements and acquisition system supporting development of new applications does not support innovative thought.

When discussing the potential application of emerging technology to psychological operations, you are only limited by your imagination. There has been a great deal of research that could be applied. For example, Department of Energy supported research has shown that laser beam absorption by gases can generate thermo-acoustic effects. This effect could be exploited to develop a large-scale direct broadcast sound generator suitable for reaching large audiences spread over square miles. Those hearing the broadcast would perceive that the broadcast was coming directly out of the sky.

C. Recommendation – Explore opportunities to leverage emerging technology advancements for applications which will enhance the capability and effectiveness of psychological operations.

Force Protection

Armored Light Tactical Vehicles

A. Observation – Other than a handful of old tanks belonging to the Pakistani contingent and a few Malaysian armored personnel carriers, there were no armored vehicles available in Somalia to support Task Force Ranger or the UNOSOM II Quick Reaction Force. Task Force Ranger used unarmored military vehicles when conducting ground movement through Mogadishu.

B. Discussion – When conducting raids, Task Force Ranger varied their concept of operations to maintain some measure of tactical surprise and to keep the Somalis off balance and not knowing what to expect next. On some raids, they would use vehicles to infiltrate or exfiltrate by ground.

These vehicles were standard unarmored HUMMVs and 2½- or 5-ton trucks. Where possible, they placed sandbags in the trucks to provide some protection. These vehicles were not well-suited for the tactical environment.

As was previously discussed, Major General Montgomery's request for armored vehicles, M-1 tanks and M-2 fighting vehicles, to provide better force protection was disapproved. Even if U.S. tanks or armored personnel carriers had been available, Task Force Ranger for practical operational and security reasons may not have used them.

While well-protected, the M-1 tank would have had difficulty negotiating some of the narrow streets and alleys of Mogadishu. Also, these tanks could not have carried any assault troops or detained personnel. Likewise, Bradley Fighting Vehicles would have difficulty operating in some of the confined areas. Also, although armored, Bradley Fighting Vehicles would have been vulnerable to massed rocket propelled grenade attacks. This would have surely been a tactic employed by the Somalis in ambushes in the narrow city streets. During fighting in Grozny, some Russian tanks were hit more than 20 times by RPGs.[18]

After Somalia, the U.S. Army made significant investments in developing strap-on armor panels for the HUMMV and obtained HUMMVs with fully integrated armor protecting the crew compartment. While this protection was sorely needed, the HUMMV with armor panels is not an ideal combat vehicle for urban operations. It can only carry 4-5 soldiers and is grossly under-powered when armored.

An armored, light, wheeled tactical vehicle is required for effective fighting in urban environments. There are a number of excellent armored, light, wheeled tactical vehicles available on the commercial market. These vehicles are built from the ground up as armored vehicles. They can provide all-aspect protection that is vital when fighting in an urban settling where you can expect firing from rooftops. With existing ceramic applique armor, ballistic protection up to .50 caliber is available. These vehicles are also light enough for deployment in C-130 aircraft. With minor modifications, some of these vehicles would prove to be superb vehicles for fighting in urban environments and protecting peacekeeping forces in such places as Bosnia and Kosovo.

C. Recommendation – Pursue non-developmental alternatives for fielding a fleet of armored light wheeled tactical vehicles and leverage advances in materials technology to reduce weight and increase the protection of future vehicles.

Lightweight Indirect Fire Location System

A. Observation – Aideed's supporters routinely fired mortar rounds into the United Nations Compound and into the Mogadishu Airport area

where the United Nations Military forces and Task Force Ranger were based. None of these forces had an effective method of locating the source of the mortar fire.

B. Discussion – After the transition from UNITAF to UNOSOM II, Aideed and his supporters became increasingly belligerent to United Nations Forces. This belligerence included firing mortar rounds into the United Nations Compound and at the Forces based inside the Mogadishu Airport area. These attacks were almost nightly occurrences during certain periods. Typically, the Somalis would fire a few rounds and quickly break down the mortar and move to a hidden location elsewhere. During such attacks, UNOSOM II and Task Force Ranger had no way to rapidly locate the source of this firing. Accurate detection of the firing location is the first step to responding to the attack.

The U.S. military, as does most modern militaries around the world, uses radar to detect and locate indirect fire, including mortars, artillery, rockets, and missiles. These systems are very capable and could have easily detected the Somali mortar firing positions with enough accuracy to respond. However, these systems are large, require generators for power, consume large quantities of fuel, and are relatively immobile. These systems are not well designed for supporting light special operations forces such as Task Force Ranger. Countermortar radar systems were included in the larger force that deployed to Somalia in response to the events of October 3, 1993.

Emerging technology in the areas of miniature sensors, advanced collaborative signal processing and mobile ad hoc networking could be merged to develop a very small, lightweight mobile system, which uses acoustic signals to locate the source of indirect fire. The technology behind each of these discrete components is well-advanced. Some acoustic signature collection and processing would be necessary to develop the signal processing algorithms specific to indirect fire systems. However, this work would be very similar to the advanced acoustic signature processing work done for the U.S. Navy submarine program.

These sensors could be networked and programmed to hear the mortar fire, recognize the sound as a firing mortar, compare notes with other sensors in the network, determine the location of the weapon fired, and automatically notify a command post/firing platform to initiate counterfire, all before the mortar round impacts.

C. Recommendation – Resource an effort to design and develop demonstration prototypes of this indirect fire location system. Other than collecting the acoustic signatures for processing, most of the research work would involve integration of the various technologies into prototypes suitable for field-testing. This effort would leverage related work and should be feasible in 36 months or less at relatively modest funding levels.

Barriers and Area Denial

A. Observation – During the fighting in Mogadishu, Task Force Ranger's only means of keeping the hostile Somali mobs back was to engage them with lethal weapons fire. At times, elements were surrounded and had to maintain fire in four directions.

B. Discussion – Material or devices which would have allowed Task Force Ranger to rapidly establish barriers to movement or deny access to an area by the Somali crowds could have been effective force multipliers. Such devices would have reduced the number of personnel needed to effectively cover an avenue of approach and kept the crowds back at distance that would have reduced the accuracy and effectiveness of their fire.

The Joint Non-Lethal Weapons Program is taking steps to address the problem by developing some items that may be of use. Some of these items are the Modular Crowd Control Munition (MCCM), Bounding Non-Lethal Munition (BNLM), Canister Launched Area Denial System (CLADS), sticky foams, and anti-traction foams. Most of these are simply non-lethal adaptations of existing lethal munitions. The JNLW program is also looking at various ways to dispense their crowd control and area denial nonlethal munitions.

There are other technologies that show potential for nonlethal area denial or creating barriers to movement. These technologies include various irritants, malodorous substances, directed energy devices, and sonic/acoustic devices. Other ideas that have been proposed have direct physical effects on the opposing personnel. Some of these ideas are sleep induction, sleep deprivation, voluntary muscle incapacitants, and induction of temporary flaccid paralysis.

Until recently, land mines were an essential tool for area denial. However, with the recent restrictions imposed on the employment of land mines, they are on longer politically acceptable for use. Small anti-personnel mines that contain means for disabling or destroying them may be acceptable. The technology exists to develop such devices.

Unattended sensors could aid in surveillance of an avenue of approach and warn that someone is approaching. These sensors could leverage a variety of emerging and existing technologies and use acoustic, thermal, seismic, magnetic or visual means. The technology exists to make these items quite small, simple to use, and compatible with existing communications equipment. The Defense Advanced Research Projects Agency has a program to develop these types of sensors. The Department of Energy laboratories also have the capability to rapidly bring this technology to maturity.

C. Recommendation – Continue to pursue the non-lethal approaches for area denial supported by the Joint Non-Lethal Weapons program, explore development of miniature mines with a self-destruct/disarm feature, and develop families of unattended surveillance sensors.

Lightweight High-Performance Protective Materials

A. Observation – The ballistic protection available to Task Force Ranger did not provide adequate protection. The protective equipment was too heavy, and too bulky and created physical stress on the operators, limiting their effectiveness.

B. Discussion – Most members of Task Force Ranger involved in the assault operations wore body armor and the standard U.S. Army Kevlar helmet. While these items were the best available at the time, they were still relatively heavy and bulky and were extremely hot for the operators to wear during the summer in Mogadishu. While these items provided lifesaving protection, they did restrict the movement and increase fatigue and stress on the operators. Reducing the bulk, weight, and heat stress on the operators, while maintaining a high level ballistic of protection, would improve the efficiency and capability of the operators fighting in environments such as Somalia.

Since October 1993, advances in technology have increased the level of protection offered by body armor. These advances have also reduced the weight and bulk. The current state of the art in commercially available body armor uses plates made of multiple boron carbide ceramic tiles with a Kevlar or Spectra fiber vest. These vests and plates can offer protection up to National Institute of Justice (NIJ) level III (7.62mm). Typically, only limited special operations forces wear these vests. They are not widely available to conventional U.S. military forces largely due to cost and failure of the requirements and acquisition process to recognize and address the problem. The NIJ Level III vest available to conventional units is very heavy and bulky to the point that it restricts a soldier's ability to move.

Some research and development is ongoing to field improved helmets. The U.S. Army Soldier Systems Center and USSOCOM both have programs to develop helmets that provide better ballistic performance with less weight. However, these efforts are not taking an innovative approach and will only yield incremental improvements to existing helmets. Very little research has been conducted on the behind armor effects or trauma caused by the deformation of a helmet when struck by a high-velocity bullet. There are no ballistic protection standards for helmets similar to the NIJ standards for body armor.

The helicopters involved in these operations also have ballistic panels to protect critical components and provide some protection for the flight crew. Just as with body armor and helmets, the bulk and weight of these items limits the amount of protection that can be installed on the aircraft without greatly reducing the operational performance of the helicopters.

Several advances in materials research show promising potential for improving available ballistic protection while reducing weight and bulk. In

the ceramics area, there appears to be the potential for integrating carbon nano-fibers to the boron carbide matrix used in the tiles of ballistic armor plates. This advancement potentially will reduce the density and brittleness of the ceramic matrix, thus requiring less material to provide the same level of protection and allowing the potential for multiple bullet strikes on each tile. Also, recent developments in carbon nano-tube production show promise for developing a completely new material for integration into ballistic protective equipment. These carbon nano-tubes may dramatically increase ballistic protection and drastically reduce the weight and bulk associated with such protection. These advancements may eventually make a ballistic exoskeleton finally possible.

The heat stress caused by wearing body armor must be addressed. It significantly reduces the effectiveness of soldiers wearing body armor, particularly in hot environments and extended engagements such as occurred in Mogadishu. A cooling system that would provide more comfortable thermal conditions would reduce heat stress on the wearer and would induce more personnel to wear their vests, thereby reducing the number of injuries and fatalities. Previous Department of Energy sponsored research has shown that specialty fibers with very high thermal conductivity can be woven into a fabric, which will transfer heat way from the wearer. This fabric could be used to construct a liner for body armor and mated with either an active or a passive cooling system.

C. Recommendation – Leverage advanced material research to develop ballistic protective materials that provide greater protection with reduced weight and bulk. Explore integrating high thermal conductive fibers into ballistic protective equipment to reduce thermal stress on wearers.

Aircraft Countermeasures for RPGs

A. Observation – The downing of the Black Hawk helicopters was the single most significant factor that caused the raid on October 3 to go from a routine raid just like the six previous to a major firefight involving significant casualties. The downing of the helicopters by RPGs highlighted a vulnerability not previously considered a serious threat. In addition to the two aircraft that crashed in the city, another Black Hawk was hit by RPG fire but managed to limp back to the airfield and make a controlled crash landing.

B. Discussion – Until the first helicopter went down, the raid was proceeding very much as expected. Even as the first helicopter went down, Task Force Ranger executed existing contingency plans and kept things well under control. However, the downing of the second helicopter exceeded Task Force Ranger's ability to effectively respond. They did not have the additional combat search and rescue teams or equipment. To an extent, the lack of additional teams was a function of the limit on the size of the force. However,

the planners probably considered the likelihood of two aircraft going down in separate locations unlikely.

The vulnerability of helicopters to RPG fire seems to have come as a surprise. A few weeks earlier, a Black Hawk helicopter belonging to the Quick Reaction Force was downed by RPG fire. However, most people seemed to have chalked that one up to a lucky shot. They regarded the RPG as a weapon meant for ground fighting.[19]

Fighting in such places as Chechnya, Angola, and Afghanistan has proven repeatedly that the RPG-7 antitank grenade is an extremely rugged, simple, and effective infantry weapon. The weapon is widely used and is becoming the weapon of choice for many infantrymen, guerrillas, and terrorists around the world. Russia has licensed its production in several countries including Bulgaria, China, Iran, Iraq, Romania, and Pakistan. Although designed to kill combat vehicles, the Afghan Mujahideen used the RPG-7 quite effectively to ambush Soviet helicopters. Typically, the Mujahideen would mass machine guns and RPG-7s around an expected landing zone. As the aircraft landed, they would hit the helicopter with massed RPG and machine gun fire. They found that a frontal shot at a range of 100 m was ideal.[20] It is certain that U.S. forces will face opponents armed with the RPG-7 for many years to come, and the weapon should be considered a threat to low-flying helicopters.

When operating in environments where RPG-7s are a threat to helicopters, both technical and procedural measures should be taken to protect the aircraft and its occupants. Helicopters flying at night are more difficult to hit. However, as night vision equipment proliferates, this advantage will diminish. Using armed helicopters as escorts and employing well-trained door gunners are steps that can discourage such attacks. However, keep in mind both were present in Mogadishu.

Providing technical countermeasures to RPG attacks is difficult for aircraft. In ground vehicles, you can use wire mesh to provide a standoff that detonates the warhead before the grenade hits the armor of the vehicle. This is not practical for helicopters. It may be possible to create a directed energy field below and to the side of the helicopter that would detonate the grenade before it hits the aircraft. Another approach that may be used is to develop "smoke grenade" launchers for helicopters similar to that employed on ground combat vehicles.

C. Recommendation – Explore technological approaches to provide low-flying helicopters protection from attack by massed RPG fires.

Unmanned/Robotic Vehicles

A. Observation – During the street fighting in Mogadishu, the streets and alleyways between buildings became kill zones. A number of soldiers were wounded or killed while crossing streets or alleyways.

B. Discussion – While in an urban fight such as occurred in Mogadishu, a street or an alley can be a very deadly place. There are occasions when soldiers need to move across the street to see what is around the corner or to carry ammunition or medical supplies to an isolated element. In such instances, small unmanned robotic vehicles may be useful and prevent loss of life.

The Defense Advanced Research Projects Agency (DARPA) has a program which is attempting to develop a family of small robotic vehicles that may aid solders when engaged in urban combat. Also, the U.S. Special Operations Command has a program which is exploring the use of small robotic vehicles for purposes such as reconnaissance.

C. Recommendation – Follow the DARPA and USSOCOM robotics efforts for possible applications.

Obscurants

A. Observation – During the fighting in Mogadishu, as in other urban environments, the streets and alleys provided excellent observation and fields of fire. The Somalis could easily see movement in the street or alleys and engage anyone moving. A means of obscuring their vision without restricting Task Force Ranger's ability to acquire and engage targets would have been extremely useful.

B. Discussion – When fighting in an urban environment, the streets and alleys generally provide open fields of fire and allow excellent observation for both parties. This creates a kill zone. When something moves in the street, it can be seen and engaged. Obscurants can be used to obscure the opponent's view, thus restricting his ability to accurately engage targets. However, existing obscurants, such as hand-tossed smoke, also restrict the friendly force's ability to acquire and engage targets. These obscurants have not kept pace with advancements in technology.

Thermal devices can see through most obscurants that are thermally uniform and relatively close to ambient temperature. Image intensification devices do not perform well when looking through smoke or other obscurants. However, these visual augmentation systems could be developed in conjunction with a new family of multispectral obscurants that would obscure the enemy's observation while allowing U.S. forces to see through.

C. Recommendation – When developing visual augmentation equipment employing thermal or sensor fusion technology, consider parallel development of a family of obscurants with multi-spectral options to limit the enemy's observation without restricting that of friendly forces.

Sniper Detection and Location

A. Observation – In the confined urban environment in Mogadishu, it was sometimes difficult to identify the location from which the Somalis were firing.

B. Discussion – Most of the sniper firing experienced in Somali was just random firing, by personnel with no sniper training, directed in the general location of U.S. or United Nations soldiers. However, even random firing can be dangerous and unnerving to the recipients. In Mogadishu, just as in fighting in the more recent conflicts in Bosnia, Kosovo, and Chechnya, personnel firing from windows and rooftops were very difficult to detect. In Chechnya, the sniper became the weapon of choice.

> One experienced sniper is capable of doing what will prove to be beyond the capability of a tank, gun, or entire infantry subunit: disable a commander, destroy a gun or mortar crew, control one or two streets … and, most important, instill in the enemy a feeling of constant danger, nervousness, and expectation of a sudden shot. Everyone fears the Chechen snipers in Grozny… There are many cases where a sniper wounds a serviceman, and then kills the wounded person and those who come to his aid.[21]

Snipers firings in an urban environment are very difficult to detect and can be extremely effective if well trained and equipped. The buildings, streets, and alleys of a city cause the sound of the weapon firing to do unpredictable things. The sound is reflected, echoed, and channeled. Thus, it is very difficult for a soldier to rely on his ears to determine the direction the firing is coming from. It is also quite easy for a sniper to hide so that there is no muzzle flash visible to the unaided eye.

The Army Research Laboratory (ARL), DARPA, and the Dismounted Battlespace Battle Laboratory at Fort Benning, Georgia, have been working with academia and industry to provide a sniper-detection system that will assist in determining the sniper's location. Their exploration has primarily focused on acoustic and infrared sensors that will accurately tell where a shot came from. One acoustic system uses a notebook-sized computer with a collapsible pole and microphones to detect the acoustical signature of the firing. The computer processes the signal and displays the location of the sniper. Another system under development by the Naval Research Laboratory (NRL) uses infrared sensors, a digital camera, and a computer to locate and provide images of the sniper. Each of the systems described are prototypes. They generally contain large, bulky components that require miniaturization and hardening before they can be effectively used by troops in the field.[22]

The problems associated with developing and fielding an effective countersniper system suitable for supporting light and special operations forces are significant. The current approaches will require major improvements in performance, miniaturization, hardening, and more reliable and long-lasting power supplies. Certain Department of Energy laboratories have researchers that have tremendous knowledge in related areas. They are capable of making some tremendous contributions to this effort in such areas as advanced acoustic signal processing, sensor miniaturization and integration as well as improved power supplies.

C. Recommendation – Leverage previous research and experience at the Department of Energy laboratories to solve the problems associated with urban sniper detection. This is not only a problem faced by the military. The Secret Service, the Federal Bureau of Investigation, and all metropolitan police departments are faced with the problem of snipers firing in cities.

Compact, Portable Electric Power Sources

A. Observation – Research and development in the area of portable electric power sources has not kept pace with development and fielding of advanced military equipment.

B. Discussion – Much of the advanced equipment currently in a soldier's hands requires batteries or another source of power. This source is often the weakest and most unreliable part of the equipment. This problem will become increasingly acute as more technologically advanced equipment is developed and fielded at a rapidly increasing pace. The power supply is often the last item considered in development and rarely do the existing military specification batteries provide the optimum source of power. The requirement for large quantities and multiple types of batteries creates a tremendous logistical burden on deployed units.

Recently, the commercial sector has experienced a large expansion in portable electronic devices. These devices include laptop computers, cellular telephones, video cameras, video games, and a proliferation of battery-operated hand tools. Electrical vehicles are also receiving increasing attention. This expansion is creating a commercial incentive to improve portable electric power supplies.

Many promising technological approaches have the potential to greatly improve the quality of the portable electric power sources available to power military equipment. Regarding batteries, these approaches include thin-film lithium batteries, lithium polymer electrolytes, lithium ion batteries, and nickel-metal hydride cells. Fuel cells, ultracapacitors, and thermophotovoltaics are also receiving increased attention.[23]

There also have been advancements into the integration of microprocessors into batteries and chargers, creating smart batteries. In these systems, the microprocessor is used to control charging rate, measure

total stored charge, and maintain a charging history. These smart batteries support greater reliability by optimizing battery charging and performance. This increased reliability should reduce battery consumption, thus reducing costs and the burden on the logistical system.

A variety of other, more exotic portable power sources have been discussed and may eventually lead to smaller and more reliable power for the multitude of electronic devices future soldiers will use. An intriguing approach is the integration of thermo/photovoltaics or a small alpha source to trickle charge a lithium cell. This potentially could create a self-recharging battery that could last for years in some applications.

C. Recommendation – The Department of Defense should encourage further research and development of compact portable electric power sources and leverage the developing technology powering a wide range of modern consumer electronic devices.

Medical Care

A. Observation – Currently, wounded U.S. forces are initially treated with bandaging and fluid replenishment techniques that have not changed significantly since World War II. Combat medics do not have medications or materials that rapidly seal wounds to stop bleeding and fluid loss. Machines that replenish fluids (blood, saline) are typically too large and bulky for use by forward-deployed combat medical personnel.

B. Discussion – If combat medics had medication or material to cause rapid blood clotting and wound closure, many lives could be saved. A very promising solution to the problem is awaiting FDA approval. The Red Cross is developing a fibrin dressing containing natural clot-forming proteins. This wound dressing uses the body's natural coagulation process to close a wound in seconds, which greatly reduces the loss of fluids and potential for wound contamination.

Combat medics regularly use intravenous (IV) bags to replenish the fluids that soldiers wounded in combat lose. The bags replenish fluids and infuse blood at a very slow rate. Present systems cannot heat or cool the fluids and do not replenish fluids at an adequate rate in cases of severe trauma. Portable trauma treatment devices that are currently under development could help critically wounded soldiers.

C. Recommendation – Encourage rapid clinical trials and FDA approval of the fibrin dressing, and distribute it to combat medics as rapidly as possible. Evaluate emerging portable trauma pump technology to reduce the cost and weight of these devices to make them useful to forward-deployed medical personnel.

5. CONCLUSION

The purpose of this paper was to review the events surrounding the firefight that took place on October 3, 1993, in Mogadishu, Somalia, from a technology perspective. The focus of this paper was on how current and developing technology could prevent a similar incident from occurring in the future and how technology could be used in a similar fight to limit causalities and reduce the potential for collateral damage in future combat situations.

Technology continues to advance quickly. As it advances, increasing amounts of high-technology weapons and equipment are proliferating rapidly. Many high-technology items are readily available on the open commercial market and can be purchased by anyone with the money. U.S. forces will fight again in situations similar to the one that Task Force Ranger faced in Mogadishu. The next time, our opponents may be equipped with a broad variety of equipment spanning the technology spectrum from crude to the ultra-sophisticated. We cannot allow the men and women of our armed forces to go into harms way without adequate weapons and equipment to give a technological edge over our adversaries.

After Action Reports, prepared after every operation or training event, should include a technology section. This technology section should address the performance of existing technology, document technological voids, and capture our soldiers' great ideas for solving these problems. Such documentation is the first and most critical step in the process of addressing technological shortfalls or applying existing technology in innovative fashions. Accurate requirement documentation is vital and must be tied directly to operational shortfalls to obtain program funds and begin the developmental effort to fill the technological void.

Every organization, at least at the Army division level, should have a technologist working as an integral team member to aggressively purse solutions where technological solutions apply. Establishing technologist positions is the first step toward making the Department of Defense acquisition structure truly responsive to commander's needs. The system must shift from a systems or platform focus to an organizational focus. Rather than focus on fielding a specific item of equipment, the system could then focus on enhancing the combat power of a unit as a whole. The U.S. Special Operations Command (USSOCOM) Program Executive Officer for Special Programs (PEO-SP) is the model for this unit-focused acquisition structure. PEO-SP's sole mission is to enhance the combat effectiveness of USSOCOM's Special Mission Units through development and rapid fielding of advanced technologies.

The technology race is moving fast. With careful planning, shrewd investments, the willingness to take measured risks, and by leveraging the

research strengths of academia, the Department of Energy laboratories, and the strong commercial sector, we can set the pace and maintain a strong lead. Experienced operational personnel must be involved in every step of the process. With this approach, we can ensure that our war fighters are equipped with the appropriate mix of technology for any environment or adversary they may face.

6. REFERENCES

1. Moskos, Charles, "Somalia Operations: Lessons Learned," Institute for National Strategic Studies, National Defense University Press, January 1995 (http:// www.ndu.edu/inss/books/allardch1.html).
2. Ibid.
3. Ibid.
4. Ibid.
5. Ibid.
6. Ibid.
7. Ibid.
8. Ibid.
9. Moskos, Charles, "Somalia Operations: Lessons Learned," Institute for National Strategic Studies, National Defense University Press, January 1995 (http://www.ndu. edu/inss/books/allardch2.html).
10. Cran, William, "Ambush in Mogadishu," *Frontline*, Interview with Major General Montgomery (http://www.pbs.org/wgbh/pages/frontline/ shows/ambush/ interviews/montgomery.html).
11. Ibid.
12. Bowden, Mark, "Black Hawk Down," Philadelphia Inquirer Online (http://www.philly.com/packages/somalia/nov16/ rang16.asp).
13. Cran, William, "Ambush in Mogadishu," *Frontline*, Commentary (http://www.pbs.org/wgbh/pages/frontline/ shows/ambush/readings/commentary.html).
14. Thomas, Timothy L., "The Battle for Grozny: Deadly Classroom for Urban Combat," Foreign Military Studies Office, Center for Army Lessons Learned, Fort Leavenworth, Kansas (http://call.army.mil/call/ fmso/fmsopubs/issues/battle.htm).
15. Cran, William, "Ambush in Mogadishu," *Frontline*, Interview with Keni Thomas (http://www.pbs.org/wgbh/pages/frontline/shows/ambush/ talk/ranger.html).
16. Bowden, Mark, *Black Hawk Down: A Story of Modern Warfare*, Atlantic Monthly Press: New York, 1999, p. 124.
17. "Joint Non-Lethal Weapons Program, 1998: A Year of Progress," published by the Joint Non-Lethal Weapons Program, January 1999, p. 1.(http://iis.marcorsyscom. usmc.mil/jnlwd).
18. Thomas, Timothy L., "The Battle for Grozny: Deadly Classroom for Urban Combat," Foreign Military Studies Office, Center for Army Lessons Learned, Fort Leavenworth, Kansas (http://call.army.mil/call/ fmso/fmsopubs/issues/battle.htm).
19. Bowden, Mark, *Black Hawk Down: A Story of Modern Warfare*, Atlantic Monthly Press: New York, 1999, p. 88.

20. Grau, Lester W., "A Weapon for All Seasons: The Old but Effective RPG-7 Promises to Haunt the Battlefields of Tomorrow," Foreign Military Studies Office, Center for Army Lessons Learned, Fort Leavenworth, Kansas (http://call.army.mil/call/fmso/fmsopubs/issues/weapon.htm).
21. Oleg Mikhaylov, "A Rare and Unpopular Specialty: About One Lesson of the New War," *Armeyskiy Sborknik*, No. 3 (March 1995), pp. 38-41.
22. Hasenauer, Heike, "Sniper Stoppers," *Sniper's Paradise* (http://www.snipersparadise.com/essays/sniperstopers. htm).
23. Fry, Dwayne N., Holcomb, David E., Munro, John K., Oakes, Lester C., Maston, Michael J., "Compact Portable Electric Power Sources," Oak Ridge National Laboratory, September 1996.